

## X-Ray Reflectivity Studies of Alkanethiolates on Gallium Arsenide (100)

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**Introduction:** GaAs is viewed as a viable alternative to silicon, due to its higher inherent electron mobility and direct bandgap. These advantages are offset by two very large drawbacks. First, the native oxide of GaAs forms an interface with the bulk lattice that disrupts the surface and induces undesirable surface states in the bandgap and point defects on the surface.<sup>[1]</sup> These oxide-induced defects act as carrier traps that diminish the electrical properties of a GaAs/overlayer structure.<sup>[2]</sup> Second, the composition and structure of the oxide varies greatly based on processing conditions and can change over time.<sup>[3]</sup> The instability of the GaAs oxide prevents its use in traditional logic-design based on the metal-insulator-semiconductor structure, the cornerstone of Si device processing. A simple, effective process to stabilize the surface of GaAs without the use of ultrahigh vacuum equipment would greatly simplify its integration into mainstream technology.

One passivation approach that has shown promise is depositing a sulfide overlayer on the GaAs using an aqueous solution. Early experiments by Sandroff and co-workers show that simply spinning a sulfide layer onto a GaAs device improved the current gain on a treated heterojunction bipolar transistor by a factor of 10. Unfortunately, this treatment is stable only for a couple of hours, before oxidation of the surface and sulfide layer degrades the observed enhancement.<sup>[4]</sup> Other workers have continue to explore the feasibility of a passivating sulfide layer due to the significant enhancement of electronic properties observed and the ease with which these layer can be grown, which has been summarized in a recent review.<sup>[5]</sup>

An extension of sulfide passivation that has been considered is the growth of alkanethiol monolayers on the GaAs surface.<sup>[6]</sup> The long chain alkanethiol monolayers adsorbed on chemically etched GaAs surfaces were found to defer interface oxidation by a minimum of 3 weeks when stored under dry air. To further understand these monolayers, characterization of the octadecanethiolate monolayer on GaAs has been performed using X-ray reflectivity (XRR).

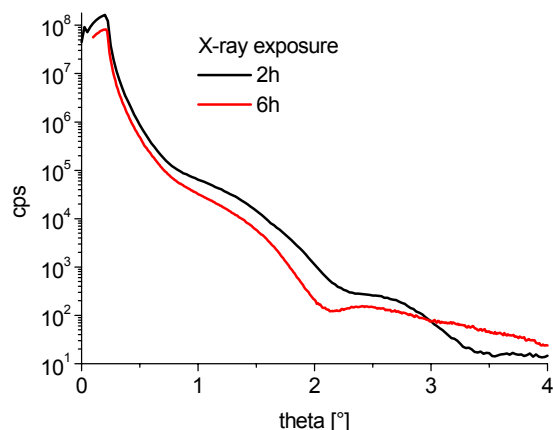
**Methods and Materials:** The  $1 \times 1 \text{ cm}^2$  GaAs(100) substrates with adsorbed octadecanethiolate were mounted inside a cell with Kapton windows that was purged with He during the measurements. Overlapping theta-2theta scans with a 10kV X-ray beam and different aluminum attenuator thicknesses were scaled and combined into one reflectivity curve.

**Results:** The reflectivity curves of fresh octadecanethiolate films show a local maximum at  $2.48^\circ$ . The peak broadens as the X-ray dose increases. A quantitative analysis is under way at present and we plan to compare the X-ray reflectivity of alkanethiolates with different chain lengths in the near future.

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**Figure 1.** X-ray reflectivity of octadecanethiolate on GaAs(100).